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Preliminary Feasibility Study of Resource Recovery for Greensboro, High Point and Winston-Salem, North Carolina (Summary Volume - Phase I)

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Prepared for

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A TECHNICAL ASSISTANCE PROGRAM REPORT

SUMMARY VOLUME

PRELIMINARY FEASIBILITY STUDY OF RESOURCE RECOVERY FOR GREENSBORO, HIGH POINT AND WINSTON-SALEM, NORTH CAROLINA

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RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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This report summarizes all of the pertinent activities of technical assistance rendered the Piedmont Triad Region; that is, the Greensboro, High Point and Winston Salem area. This study also gives an overview of the concern of citizens and officials in the development of resource recovery in the area and the conclusions reached by the Piedmont Triad Council of Governments subsequent to receiving technical assistance.

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PRELIMINARY FEASIBILITY STUDY OF RESOURCE RECOVERY FOR GREENSBORO, HIGH POINT AND WINSTON-SALEM, NORTH CAROLINA

SUMMARY VOLUME

PREPARED FOR

OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV, ATLANTA, GEORGIA

BY

CSI RESOURCE SYSTEMS, INC.
BOSTON, MASSACHUSETTS

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SUMMARY VOLUME

Genesis and Purpose of Preliminary Feasibility Study

Beginning in the early Seventies, municipal solid waste (MSW) came to be recognized as a potentially abundant alternative source of energy and resusable materials. Since then, the Arab oil Embargo of 1974, with its dramatic price hikes, and subsequent events have resulted in a corresponding increase in the potential value of MSW. On the average, one ton of solid waste contains about nine million Btu, the energy equivalent of 1.4 barrels of refined oil or one-third a ton of coal. Each day of the week about 1550 tons of solid waste is generated by the Triad Region cities of Greensboro, High Point and Winston-Salem, and must be buried in one of six landfills serving Guilford and Forsyth Counties. If the energy in that 1550 tons of solid waste were recovered, a savings of 2170 barrels of refined oil products per day could be realized, or nearly 800,000 barrels saved per year.

Greensboro officials investigated resource recovery and concluded as early as 1975 that it would be extremely desirable to recover the energy contained in its solid waste resources. In response to local and national interest in resource recovery, the Piedmont Triad Council of Governments (PTCOG) undertook an investigation of the potential for resource recovery in its nine-county membership area. A major recommendation contained in its July 1978 report, entitled The Potential for Resource Recovery in the Piedmont Triad Region, was that:

> "Additional investigation is recommended into a high-technology system. A detailed design and economic analysis could integrate the existing facilities [the shredder facilities in High Point and Greensboro] with a regional network and develop cost estimates."

It is important to recognize at the outset that undertaking the necessary feasibility investigations; resolving the technical, environmental, financing, and legal/financing issues; and determining the appropriate strategy for procuring a recovery system is a serious and expensive undertaking.

City officials and citizens also need to recognize that implementation of a high-technology resource recovery project represents an entirely new type of venture for them. Implementation of a resource recovery project involves the design, financing, construction, and operation of what can best be viewed as a manufacturing plant which produces saleable products (energy and possibly reusable materials). A resource recovery facility must perform reliably two functions. First, it must substantially reduce the volume and quantity of solid waste ultimately requiring disposal at a sanitary landfill. Second, it must consistently produce energy and other products to buyer specifications, so that revenues are generated to meet debt service payments on the capital investment made to build the manufacturing facility.

Resource recovery is a relatively new endeavor in this country. As a result, there is limited operating history upon which to base long-term performance estimates for resource recovery systems; to estimate the length of time required to bring a completed facility to full-scale, steady-state operations; and to accurately predict the annual operating, maintenance, and repair costs. In addition, continual modifications and innovations are being made--even to solid waste combustion technology borrowed from Europe, which has some 20 years of operating history. Thus, even "proven" technologies have significant uncertainties and attendant long-term performance risks.

Finally, the implementation of a recovery project is more complicated than most endeavors typically undertaken by local governments. The participants involved in bringing a resource recovery system to reality have different objectives and concerns, which must be equitably harmonized in order to ensure the economic and technical integrity of the project. Six major participants are involved in the successful implementation of a recovery project:

- Sponsor of the project, who is responsible for structuring the project so that it will be successful over the long term and is responsible for negotiating with other participants.

- Suppliers of waste (who may or may not be the same as the project sponsor), who want their waste disposed of on a reliable, long-term basis at the lowest practicable cost, but may have problems with a put-or-pay arrangement.

- Buyer of energy (and reusable materials), who wants reliable delivery of energy at his specifications at the lowest price possible, but may not want to enter into a take-or-pay agreement.

- Vendor of system, who generally is interested in performing the engineering design, overseeing the construction, and operating the facility on behalf of the sponsor; and who, in exchange, may be prepared to provide long-term guarantees that the system will perform as represented, provided the waste quantity and composition are not different from those represented by the sponsor and liabilities for failure are not too severe.

- Investment bankers, or underwriters, whose prime interest is that the sale of bonds will be as easy as possible and that the interest rate on the bonds will be as low as possible to the issuer of the bonds.

- Investors in bonds issued to finance the project, who insist that risks associated with certain project factors be eliminated or minimized in order to be certain that there is no risk exposure (i.e., that they will always receive interest and principal payments) to their investment.

Rather than commit substantial local dollars to project development before determining that the essential ingredients for implementing a resource recovery system were likely to be present, Greensboro (with the support of High Point, Winston-Salem and Guilford and Forsyth Counties) requested technical assistance from the U. S. Environmental Protection Agency under the provisions of the Resource Conservation and Recovery Act of 1976. The purpose of this assistance was: 1) to assess whether Duke Power represented a viable buyer and whether other potentially viable energy buyers might exist; 2) to assess what kind of system might be available to meet the energy needs of the buyers, and 3) to provide a preliminary indication of the economics of a resource recovery project in the Triad City region.

Principal Findings

Four ingredients must exist for a resource recovery project to be considered seriously. First, there must be interested buyers whose energy requirements and costs (of fossil fuel) would utilize enough waste to generate sufficient revenues to justify the decision to invest in an energy recovery system. Second, there must be a proven resource recovery technology capable of reliably processing the available solid waste to the day-in, day-out energy requirements of the prospective energy buyer(s). Third, there must be a reliable supply of solid waste sufficient to keep the plant operating. Fourth, there must exist suitable sites within reasonable transport distance of potential energy buyers which could be made available for a recovery facility. Of course, any solution must be environmentally sound, financeable, and legally implementable.

This technical assistance effort utilized the above criteria as a screen. Seven possible resource recovery options which could serve one or more of the Triad Region's principal cities emerged.

The seven resource recovery options which emerged were classified into four categories: highly promising, promising, having potential, and unlikely. These resource recovery options, their proposed sources of waste, and their projected 1983 net dispsoal costs (per ton of processed waste) follow:

Highly Promising

- Winston-Salem 250 TPD_6 Modular Combustion System - Using a portion of the available and processible 520 TPD_6 of solid waste generated in Winston-Salem to produce steam for Hanes.

  NET DISPOSAL COST: $4.60/ton of waste processed

Promising

- Greensboro 624 TPD_7 Waterwall Combustion System - Producing steam for Lorillard and A&T University from all of the available and processible solid waste generated by Greensboro.

  NET DISPOSAL COST: $7.60/ton of waste processed.

Potential

- High Point 90 TPD_6 Modular Combustion System - Using a portion of the available and processible 200 TPD_6 of solid waste generated by High Point. Producing steam for J. P. Stevens.

  NET DISPOSAL COST: $4.10/ton of waste processed.

- Greensboro 471 TPD_6 Waterwall Combustion System - Using a portion of the available and processible 730 TPD_6 of solid waste generated by Greensboro. Producing steam for Cone.

  NET DISPOSAL COST: $12.50/ton of waste processed.

Unlikely

- Decentralized 1015 TPD_6 RDF System - Using all of the available and processible 1015 TPD_6 of solid waste generated by Greensboro, High Point, and Winston-Salem. Producing RDF for Belews Creek.

  NET DISPOSAL COST: $11.00/ton of waste processed.

- Greensboro 624 TPD_7 Waterwall Combustion System - Producing steam and electricity for Lorillard from all the available and processible solid waste generated in Greensboro.

  NET DISPOSAL COST: $10.20/ton

- Greensboro 624 TPD_7 Waterwall Combustion System - Producing steam and electricity for Cone from all the available and processible solid waste generated in Greensboro.

  NET DISPOSAL COST: $15.90/ton

Advantages and Disadvantages of Recovery Options

The following four pages present in summary form the relative advantages and disadvantages of the various resource recovery system options:

ADVANTAGES AND DISADVANTAGES OF RECOVERY OPTIONS

Decentralized 1015 TPD_6 RDF System

Advantages

- Regional solution
- Utilizes all processible waste in two counties
- Builds upon current disposal facilities and practices
- Available sites located at existing landfills

Disadvantages

- Value of RDF per mm Btu substantially less than from steam
- Wide variation in costs to respective communities with very high net costs to High Point
- Truck transport of RDF consumes substantial quantities of expensive and less available diesel fuel
- Approximately 44 percent of available waste remains as a process reject or residual and requires ultimate landfilling
- Risk of negative price for RDF
- May require protracted negotiations with Duke Power
- All system performance risks are borne by three cities

Greensboro 625 TPD_7 Waterwall Combustion or Dedicated Boiler System with Steam to Lorillard and A&T University

Advantages

- Cost competitive projected net disposal costs
- Accepts all of Greensboro's processible waste
- Existing potential site
- Meets average hourly steam demand at Lorillard

Disadvantages

- Energy purchaser's concerns that its customer may react negatively to concept of "producing cigarettes from trash"
- Difficulty in coordinating steam product with customer's energy demand, especially at A&T University during winter
- Requires major steam line to A&T University and uncertainty that right of way can be obtained
- Potential for adverse traffic impacts
- May eliminate use of investment in new shredding plant

Greensboro 625 TPD_7 Waterwall Combustion or Dedicated Boiler System with Steam and Electricity to Lorillard

Advantages

- Accepts all of Greensboro's processible waste
- System has flexibility in matching energy production to customer's energy demand
- Existing potential site
- Meets Lorillard steam and portion of electricity demands

Disadvantages

- Technical uncertainties to the cogeneration of steam and electricity from a resource recovery system of this scale
- Energy purchaser's concerns that its customers may react negatively to concept
- Potential for adverse traffic impacts
- Value of electricity product low
- Duke Power may resist purchasing excess electricity

Greensboro 470 TPD_6 Waterwall Combustion or Dedicated Boiler System with Steam to Cone

Advantages

- Meets Cone's average hourly steam demand
- Vacant site in close proximity to Cone's boiler plant and steam line

Disadvantages

- In view of recent consolidation at its Greensboro complex, Cone's commitment to continual operations in the area must be ascertained
- System processes only $\simeq$ 65 percent of the available processible waste
- Projected net disposal costs of $12.50 per ton are significantly higher than costs of current disposal operations
- Potential for adverse traffic impacts
- Uncertainty that site could be obtained from Cone

Greensboro 625 TPD_7 Waterwall Combustion or Dedicated Boiler System with Steam and Electricity to Cone

Advantages

- Accepts all of Greensboro's processible waste
- System has flexibility in matching energy production to customer's energy demand
- Existing potential sites

Disadvantages

- Technical uncertainties to the cogeneration of steam and electricity from a resource recovery system of this scale
- Projected net disposal costs of $14.60 per ton are significantly higher than costs of current disposal operations
- Cone's commitment to continued operations at the Greensboro complex must be ascertained
- Value of electricity produced low
- Duke Power may resist purchasing excess electricity
- Potential for adverse traffic impacts

High Point 90 TPD_6 Modular Combustion System with Steam to J. P. Stevens

Advantages

- Projected net disposal fee cost competitive with existing practices
- Potential customer appears committed to converting existing power plant from increasingly expensive and scarce fuel oil
- Scale and technology of system allows for reasonably speedy implementation

Disadvantages

- Significant siting difficulties must be overcome
- Because of J. P. Stevens' modest energy demands, additional customers may be required to assure economic viability
- System's capacity limits the quantity of waste which can be accepted to about 40 percent of available waste
- Possible severe traffic congestion

Winston-Salem 250 TPD_6 Modular Combustion System with Steam to Hanes

Advantages

- Projected net disposal fee cost of $4.60/Ton competitive with existing practices
- System presents opportunities to consolidate existing facilities and effect disposal savings
- Available site located at existing landfill
- Scale and technology of system allows for a reasonably speedy implementation

Disadvantages

- System's capacity limits the quantity of waste which can be accepted to about 50 percent of available waste

Recommendations

It is recommended that the Triad area continue work to implement two energy recovery projects: one project would be located in Winston-Salem, involving the sale of steam to Hanes; the other project would be in Greensboro. In Greensboro, however, a decision would have to be made between two separate resource recovery alternatives. The first alternative is the production and sale of steam to Lorillard as the prime customer, with surplus steam being sold to A&T University on an interruptible basis. The second alternative is to produce and sell steam to Cone Industries.

In addition, a possible project may exist in High Point involving the production and sale of steam to a J. P. Stevens facility if siting difficulties can be overcome.

The preliminary assessment indicates that a regional approach involving the production of a Refuse Derived Fuel (RDF) for sale to Duke Power for use as a supplementary fuel at the coal-fired Belews Creek plant is not economically feasible and thus should not be pursued further.

Implementation efforts in each City should immediately focus on verifying the interest initially (and cautiously) expressed by the prospective energy buyers. Responsible Greensboro officials should give priority to meeting with their counterparts at Lorillard, to see if resource recovery is compatible with Lorillard's announced $250 million plant expansion program.

Should these efforts confirm the existence of a viable buyer, then the scope of effort should be broadened to include: an in-depth determination of system requirements, analysis of project economics based on a preliminary design, identification and resolution of environmental and legal/institutional concerns, and a structuring of the system procurement to assure that the project can be financed.

Technical Summary

A feasible resource recovery plant reliably converts waste into saleable products which generate revenue to offset some project costs. For an initial screen, project viability usually relies on a match between energy production and customer needs. Hence, it was necessary to determine whether viable energy buyers exist in the Triad area, to identify the generic types of technology which can provide a match between the buyer's requirements and the quantity of available solid waste, and to assess whether the estimated net cost associated with the buyer-technology combination seemed reasonably comparable to the 1983 estimated cost of alternative solid waste disposal in landfills.

Energy Market Survey--Investigation of the existence of potentially viable energy buyers dealt with both manufacturing and non-manufacturing concerns as well as with Duke Power. The non-utility buyers were investigated in order to determine the existence of buyers who use steam for process applications and heating and cooling. Duke Power was investigated to determine the viability of producing Refuse Derived Fuel (RDF) from the solid waste generated by two or more of the Triad cities for sale to the Belews Creek facility of the utility.

From a list of nearly 50 (manufacturers, universities, colleges and hospitals supplied by the three cities, 30 possible buyers were selected for interviews by telephone and/or personal visits. The purpose of the interviews was to assess the degree of interest each had in the concept of purchasing recovered energy; the type of fuel which would be displaced; the current price for fuel and the estimated cost of producing steam for internal consumption; type and age of boiler and fuel storage systems in use and plans for replacement or expansion. Additional information solicited included average hourly steam consumption, seasonal patterns in steam consumption, steam pressure and temperature requirements, number of daily shifts operated, the number of days operated weekly and annually, and any other special considerations or factors that needed to be recognized. A number of establishments contacted indicated they were not interested: many of them because they already used alternative fuel sources (e.g., wood wastes generated in their manufacturing process, or waste heat from their processes) or had only a limited seasonal use for steam (primarily during the heating season). Other establishments contacted, while expressing some interest in the concept, indicated that their average hourly steam usage was low (less than 10,000 pounds per hour--the equivalent of about 50 TPD of solid waste), that they operated only one or two shifts per day, or that finding a site for an energy recovery facility would be extremely difficult because of significant residential development of the surrounding areas.

Only five of the interviewed buyers appeared to warrant consideration for further investigation:

Greensboro:

- Cone Industries
- Lorillard and/or A & T University

High Point:

- J. P. Stevens (West Avenue facility)

Winston-Salem:

- Hanes Corporation (Route 52, Weeks Plant).

These five establishments were judged to meet the following considerations acceptably:

- Each concern expressed interest in the concept of utilizing energy recovered from solid waste. It should be noted that in no case was enthusiastic interest expressed. However, since the contacts were made prior to the recent dramatic oil price increases imposed by OPEC, the degree of interest may have significantly increased in the interim.

- At each facility low-pressure steam--an energy form which can be readily produced from various resource recovery technical options--is used for processing and/or for year-round heating and cooling needs, average hourly steam loads are generally high, seasonal variations in steam usage appear to be within an acceptable range, and no unusual pressure or temperature requirements exist.

- The respective plants operate on a three-shift, five-to-six-day week, indicating potential for a high-capacity utilization factor.

- At each facility oil would be the fuel displaced, and the fuel component cost of producing steam at time of survey was about $2.50 per thousand pounds of steam (the minimum cost acceptable for viable project economics, based upon economic analysis fpr recovery projects elsewhere in the country).

- For each prospective energy customer, potentially available vacant sites exist which appear to be of adequate size and located within a reasonable steam transport distance of the respective establishments.

- Each organization has been located in the Triad area for a number of years and can probably be considered a long-term energy buyer.

The subsequent evaluation of Duke Power as an energy buyer found that:

- Duke still remains an interested buyer of RDF.
- A RDF processing facility would have to be located off-site from the Belews Creek plant.
- The 1983 projected cost of coal to Duke Power is quite low--about $2.25 per million Btu (compared to the 1979 current cost of $2.50 per million Btu to users of oil).
- Discounts for incremental capital and operating maintenance costs associated with burning RDF, and penalties for boiler derating and economic dispatch could reduce the 1983 effective price Duke Power is willing to pay to 75¢ per million Btu and pose the risk that under conditions of economic dispatch there could be a negative price (i.e., Duke would have to be paid to burn RDF).
- Duke Power is not interested in purchasing electricity generated from a dedicated small power plant (about 25 MW) which utilizes solid waste as the fuel source.
- In 1978 Duke Power's system-wide cost of producing electricity was only 28 mils per kilowatt hour (a mil equals 1/10 of a cent). A system-wide cost, rather than fuel cost, would be the most favorable basis for pricing electricity sold to a private investor-owned utility because it includes the capital costs of facilities that go into the rate base, as well as the cost of all types of fuel used to generate electricity in the system. Because of the high cost of turbo generators and high operating and maintenance (O&M) costs associated with producing moderate pressure steam (650-800 psig) from solid waste, other analytical studies suggest that the price received for electricity should be at least 60 mils per kilowatt hour, in order to offset the advantages of producing low-pressure steam for sale to a prospective steam buyer using oil). Although the factors affecting the sale of RDF to Duke Power did not appear as favorable as those involving the sale of steam to potential industrial buyers, it was decided to continue evaluating the utility as a potential buyer because of their expressed interest and in order to determine the economics of a regional system.

Steam Buyers--Assessment of technologies appropriate to the needs of the candidate steam buyers was restricted to more or less "proven" generic systems. Each of these generic systems is in full-scale operation in at least one recovery project elsewhere in the U. S. or Canada. Because of interest expressed by Lorillard and Cone Industries in cogeneration (i.e., the production of electricity and extraction of steam from turbines for use in manufacturing processes and/or heating and cooling), economic analysis was made of this concept, even though it did not fully meet the "proven" criterion. The proven concepts selected for each buyer were:

- Lorillard and Cone Industries - a waterwall combustion system or dedicated boiler system. Under the waterwall combustion technology unprocessed refuse is burned mechanically on moving grates in a combustion chamber, containing closely spaced water-filled tubes which transmit heat radiated from the combustion process to an attached heat recovery boiler, which generates steam. Cooled combustion gases pass through electrostatic precipitators for air pollution control before being vented to the atmosphere through a stack. The dedicated boiler technology differs in concept in that oversized materials are removed from the solid waste, which is then shredded to a nominal air particle size and passed under a magnet to recover magnetic metals. This coarsely shredded material is fired as a primary fuel in a "dedicated" boiler. Design throughput of refuse for the Lorillard system is 624 TPD_7 and for Cone 471 TPD_6.

- J. P. Stevens and Hanes - modular, starved-air combustion system, in which unprocessed waste is mechanically ram-fed into a lower combustion chamber, where it decomposes through a semi-pyrolysis partial combustion process into a carbon monoxide-rich gas, which passes into a secondary chamber serving as a low-Btu gas burner where smoke and other large particles of incomplete combustion in the lower chamber are burned. Hot gases leaving the secondary chamber pass through a heat exchanger to produce steam, and from the heat exchanger through a baghouse for air pollution control before being vented to the atmosphere through a low stack. Design throughput of refuse for the Stevens' system is 90 TPD_6, and for Hanes is 250 TPD_6.

The cogeneration concept for Lorillard includes addition of superheaters to increase steam temperature, addition of turbine/generator sets and switch gear to generate electricity, and elimination of the steam line to A & T University. The cogeneration concept at Cone would entail a combustion system with a larger throughput capacity--624 TPD_7 instead of one rated at 471 TPD_6--plus the same additions required for the Lorillard system.

Duke Power--Examination of Duke Power as a buyer of RDF began several years ago when (with support of Guilford County and High Point), Greensboro officials took the lead in exploring with top personnel of Duke Power the concept of burning RDF as a supplementary fuel to coal at Belews Creek. Duke Power expressed interest in such a possibility, but indicated that in order to justify the necessary boiler modifications somewhere in the vicinity of 1000 tons per day of RDF would be required six days a week. A 1000 TPD_6 of RDF meant that nearly 1800 TPD of raw solid waste would be required--representing approximately the entire waste generated by Greensboro, High Point and Winston-Salem. Furthermore, the particle size of the RDF to be burned at Belews Creek would have to be less than one inch. Such a dimension was considerably smaller than the nominal 4-inch particle size of shredded waste at High Point and that contemplated at Greensboro. To achieve such a small, uniform particle size would entail additional processing. In addition to the size considerations, the experience gained in St. Louis revealed that it was essential to have a very low proportion of non-combustibles such as dirt, metal and glass in the RDF. Removing abrasive non-combustibles is necessary to ensure that the supplementary fuel does not wear out the feed ducts to the boiler. The small size for the RDF is needed for proper burning, so that unburned material does not fall into the furnace and plug the bottom of the boiler. In order to achieve the quality requirements for RDF, installation of additional, expensive size control and contaminant removal equipment would be required. Given these considerations, the momentum initially generated by Greensboro slowed perceptible; although interest in the concept of energy recovery remained high.

Economics of Resource Recovery Options

First-order cost estimates were prepared for each of the seven systems passing the technology and market screens. These estimates were prepared in current dollars. However, since none of the large-scale systems would likely be operational before 1983, current dollar estimates were escalated to reflect first-year operating economics. For the steam production and cogeneration concepts, it was assumed that there would be private sector equity contributions. This form of financing would provide attractive rates of return on the private investment due to Federal debt service income tax shelter benefits, and at the same time reduce the net annual debt service cost to the city sponsors of the projects because of smaller required bond issues. For the RDF system, financing was assumed to be through General Obligation bonds issued through the North Carolina Local Government Assistance Commission.

The results of the economic analyses are summarized in the following table. The detail assumptions underlying the economics for each option are contained in the companion technical report. However, a few comments are provided with respect to the differences in annual

SUMMARY OF RESOURCE RECOVERY OPTIONS
(1983 Dollars)

	RDF	Lorillard		Cone		Hanes	Stevens
		Steam	Cogen.	Steam	Cogen.		
Processible Waste TPY (1983)	565,740	284,710	284,710	146,952	284,710	65,000	27,000
Capital Cost ($000)	17,735	55,086	62,906	42,987	62,906	9,768	5,064
Less: Energy Revenues ($000)	3,736	5,649	5,611	3,399	4,553	1,424	710
Net Disposal Cost ($000)	6,242	2,169	2,904	1,828	4,533	301	111
Net Disposal Cost per Ton	11.10	7.60	10.20	12.50	15.90	4.60	4.10

costs and revenues for the cogeneration options at Lorillard and Cone Industries. First, annual costs are probably higher for the Cone system because the heavy surrounding development indicates a need to minimize traffic and deliver refuse by transfer trailers rather than packer vehicles. Refuse transport in transfer trailers adds about $2 per processible ton to the net disposal cost. Second, annual revenues differ between the two due to differences in the mix of steam and electricity produced. Lorillard has an average hourly steam load that is about 25 percent greater than Cone. As a result, more steam can be extracted from the turbines. This reduces the amount of electricity that can be produced. Since the value of steam is greater than the value of electricity, more revenues are produced. Also, the value of steam sold to Lorillard is greater than that sold to Cone because of differences in sulfur content, hence price, of oil being displaced.

The resultant economic analysis may be overly conservative for two reasons: First, energy revenue estimates are based upon distillate fuel costs reported by the respective organizations as of January 1979. These costs were then escalated to 1983, assuming a 15-percent compounded rate of inflation. The result is that the estimated fuel component cost of energy to each is probably understated, since between January and June 1979 the cost of distillate fuel increased by nearly 60 percent at Norfolk, Virginia, the major southeast port of entry and fuel oil terminal. This rate of increase in six months is substantially greater than that assumed in the economic analysis for the period 1979-1983. Second, no account has been made of likely increases in landfill costs incurred as a result of sanitary landfill criteria and landfill upgrading guidelines promulgated, or in the process of being finalized, by the U.S. Environmental Protection Agency in response to mandates under the Resource Conservation and Recovery Act of 1976. It is anticipated that incremental costs associated with conforming to EPA requirements will be most noticeable for landfills handling 300 TPD or less of solid wastes. Since each of the three landfills in Winston-Salem and the one in High Point handle less than 300 TPD, it is possible that any upgrading required could significantly increase disposal costs on a per-ton basis at these facilities.

Next Steps

The market technical and economic screens are preliminary, whose purpose is to determine if any project is possible. Nevertheless, they indicate that the region could undertake at least two recovery projects. However, a number of issues must be resolved and tasks performed before a final decision can be made to procure the more promising of the system options.

Issues requiring resolution and tasks to be performed fall into seven categories:

- Energy market verification
- Waste characteristics, impacts and economics
- System definition
- Procurement methods and sponsorship form
- Financing strategies
- Risk allocations
- Legal and institutional barriers.

Energy Market Verification--The preliminary market study indicated that there were prospective customers interested in the concept of purchasing energy from a resource recovery project. This interest was both preliminary and cautious. For that reason, the level of commitment must be established for each of the prospective customers to ensure that in fact there will be an energy buyer if the project proceeds further.

Having established a commitment to purchase energy from a resource recovery project by one or more prospective customers necessitates the formulation of the principles of a purchase arrangement between the energy buyer and the sponsor. These principles include optional ways of pricing the energy, and establishing the length of the purchase contract and negotiating a firm put-or-pay concept, as well as developing pricing escalators.

For each prospective customer, detailed energy load profiles must be developed, including seasonal energy variation, daily energy requirements, and electrical consumption.

Consideration should also be given to future industrial growth trends. The prospect of available and competitively priced energy from a resource recovery system could serve as a strong catalyst for industrial development. The possibility of attracting a new energy customer to the area should not be overlooked.

Waste Characteristics, Impacts and Economics--While a preliminary characterization of the region's solid waste practices and composition has been done, considerable additional work must be performed. First, accurate waste composition data must be obtained to determine the actual characteristics of the waste, including quantities generated, quantities processible, and the Btu content of the processible solid waste. Second, the economic and operational impacts of resource recovery upon existing collection and disposal practices must be determined. It must be determined whether there will be incremental savings attendant with resource recovery; or whether the cost of resource recovery will be additional to existing disposal costs. Third, it must be determined whether private haulers will deliver their waste to resource recovery systems or whether, because of perceived or real savings, they will elect to deliver the waste to other disposal facilities. Fourth, projected traffic impacts resulting from changes in current practices in delivery of waste to a resource recovery facility must be ascertained. As well, the optimal mode of waste delivery to a new resource recovery facility must be determined. Is it better to deliver the waste in packer truck, or should the waste be consolidated at the existing disposal site, loaded into a transfer trailer, and delivered to the resource recovery system?

System Definition--The energy requirements and practices of the prospective customer, to a large extent, define the scale and technology of the resource recovery system. Customer-specific issues, such as siting impediments and steam line requirements, can effect significantly the capital costs of otherwise similar systems.

The four resource recovery options appropriate to Greensboro were based upon the production of steam as the primary energy product from a waterwall combustion technology or a dedicated boiler concept wherein coarsely shredded solid waste with oversized bulky materials and magnetics removed is fired in a specially designed solid waste fuel boiler to produce steam.

Because either technology appears technically feasible, further effort must be devoted to define the most appropriate systems to serve the prospective energy customers.

Procurement and Sponsorship--The appropriate procurement strategy must be developed to ensure that both risks and costs to the participating communities are minimized. A choice must be made between an architect/engineer (A/E) and turnkey full-service approach.

Furthermore, it should be determined whether the city, the county, or a specially created authority would be the best sponsor of a particular resource recovery project.

Financing Strategies--The optimal financing strategy must be ascertained to ensure that a cost-effective financing method is employed. Choices must be made between the use of tax-exempt general obligation and industrial revenue bonds, private-sector equity participation and combinations thereof.

Risk Allocation--System availability, reliability and maintainability are key risk parameters attendant with any resource recovery system. Therefore, it must be determined whether prospective vendors are prepared to offer bonding over the full life of the bond issue, as in a turnkey approach, or whether the sponsoring agency or participating communities must shoulder the majority risk of economic or technical uncertainty. Mechanisms to deal with the default of a vendor or buyer must be addressed and force majeure events such as changes in the waste composition or environmental laws must be defined.

To reduce the economic risk of resource recovery, firm put-or-pay commitments must be obtained from the waste-generating communi-

ties, and take-or-pay contracts from the energy customers.

Under a put-or-pay contract the waste generating communities agree to deliver a minimum quantity of solid waste and to pay a tipping fee based on that quantity, whether waste is delivered or not.

A take-or-pay contract obligates the energy customer to pay for the fuel or energy produced by a resource recovery system whether he accepts it or not.

Legal and Institutional Barriers--Numerous legal and institutional barriers to the implementation of a resource recovery project exist, primarily due to the fact that few projects have ever been implemented. Institutional and legal barriers, including site acquisition issues, the implication of traffic impacts upon the surrounding neighborhoods and/or communities, the legality of long-term put-or-pay and take-or-pay contracts, the prospect of mandatory participation of private haulers, all must be resolved in an appropriate and timely manner.